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ELECTRICAL CONTACT BRUSH

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The invention relates to electrical contact brushes, and more specifically to carbon brushes for use in electrical machinery required to operate under conditions such as exist in the atmosphere at high altitudes.

Well-made brushes composed of natural or artificial graphite, or other commercial forms of carbon, or of mixtures of carbon and one or more metals such as copper and silver, are very durable when operated in sliding contact against copper commutator bars or slip-rings at sea level or at altitudes up to about 15,000 feet. At high altitudes brush wear is substantially accelerated, and under atmospheric conditions encountered at altitudes over 25,000 feet above sea level, the rate of wear of conventional brushes is extremely rapid. For example, a standard high-quality carbon brush, when operated against a copper commutator in air at 30,000 feet, wears almost as rapidly as if it were bearing against an abrasive wheel, and instances are known where brushes have worn out completely in less than an hour at these altitudes. The most suitable of the known brush compositions may in some instances last several hours; but at best the brushes can not be relied upon for long.

Modern aircraft use electrical motors, generators, and other electrical devices requiring contact brushes. Both military and civil aircraft are being designed to operate at great altitudes, and there is an urgent demand for electrical contact brushes that will operate dependably over a useful long life at such altitudes. The principal object of this invention is to meet this demand.

The reasons for the poor behavior of brushes at high altitudes are not altogether clear; but it seems certain that two important factors are the dryness and the low oxygen pressure of the air. A similar behavior has sometimes been observed, during periods of unusually dry winter weather, even at low altitudes in the cases of some brush compositions; but the problem has not been a serious one. By operating brushes in a test chamber in which the atmosphere can be controlled, it has been found that either a low moisture content or a low partial pressure of oxygen may cause rapid brush wear, and it has also been found that many expedients which overcome the trouble caused by dry air do not materially offset the ill effects of a low partial pressure of oxygen.

These observations suggest that an important factor in the satisfactory operation of a carbon brush at low altitudes is a film between the commutator or ring and the brush, which film is maintained by moisture and oxygen in the air.

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Further support for this hypothesis, and a suggestion that other film-forming materials might be substituted for moisture and oxygen, are found in the observation that new electrical apparatus, still containing traces of slightly volatile compounds in its insulation and paint, may not give trouble at high altitudes until after several weeks or months of use. This latter circumstance increases the hazard, because rapid brush wear may start without warning after a considerable period of satisfactory operation. In an airplane several hours from its base the brushes may suddenly start to wear at a rate which will destroy them in an hour.

One approach to the problem is to incorporate in the brush, or impregnate the brushes with, one or more substances which will establish and maintain a suitable film between the commutator or slip-ring and the carbon brush. The choice of a suitable material is a difficult one, for much more is involved than the mere provision of a film-forming material. The material must be effective in small amounts, because the interstitial storage space in a brush body is not very great. If it is to be an impregnant, it must be a liquid or liquefiable by melting or by solution to make impregnation possible, and it must have ability to penetrate thoroughly both inner and outer pores of the carbon. In any case, it must not evaporate rapidly, and it must not exude, for exudation may result not only in undue depletion of the impregnant but also in the formation of a surface layer which tends to pick up dirt and to interfere with the smooth operation of the brush in its holder. Finally, the film which the material supplies must have a low electrical resistance, must not pick up dirt nor decompose to deleterious products, and must be stable under a wide variety of conditions of atmosphere, temperature, and of mechanical and electrical stresses. Dozens of brush impregnants, including such materials as paraffin wax, beeswax, carnauba wax, linseed oil, ethylene glycol, greases, oleic acid or sodium oleate, and calcium chloride have been proposed for use at low altitudes, but for the problem here considered prior-known impregnants have given unreliable results. In many tests of old impregnants there were a few which improved brush life under some operating conditions, but none were found which increased the life to a commercially satisfactory level under the conditions existing at altitudes above 25,000 feet, and at the same time satisfied the other requirements indicated.

The principal object achieved by this invention

is a carbon brush having improved life and good operating characteristics at altitudes well above 25,000 feet, for instance at 40,000 feet.

The invention is an electrical contact brush comprising carbon or graphite, which may include a metal such as copper or silver, and also including a minor proportion of one or more compounds of at least one of the rare earth elements of the thorium, cerium, and yttrium groups. These groups include, in addition to thorium, cerium, and yttrium, the very rare elements lanthanum, neodymium, praseodymium, samarium, erbium, holmium, thulium, dysprosium, ytterbium, lutecium, and illinium. These latter elements usually are found with the former in their natural ores and sands, and are not available commercially except in various mixtures which also include the principal rare earth elements thorium, cerium, and yttrium. Sometimes the commercial mixtures are byproducts of the manufacture of thorium or cerium and therefore contain but little of these elements. Compounds of any of these mixtures, as well as of the commercially pure thorium, cerium, or yttrium, may be used in this invention.

The particular compound used is not of controlling importance, but the ready availability of the oxides and salts particularly recommends their use. Fluorides are quite satisfactory.

The weight percentage of rare earth element compounds is not critical, but in general it is preferred that as much be added as possible without materially decreasing the strength and electrical conductivity of the brush. Rare earths or rare earth metal fluorides amounting to about 15% by weight of a graphite-copper brush is suggested as a suitable, but not limiting, proportion.

Insoluble compounds, such as the oxides, or compounds of low solubility in common solvents, may be added as dry powder to a powdered graphite, carbon, or graphite-metal molding mixture which is then formed, compacted, and heat treated in conventional manner. Soluble compounds,

such as the chlorides or acetates, are preferably incorporated by impregnating a completed brush with a solution of the compound and removing the solvent by evaporation. The impregnation can most conveniently be effected under vacuum. Such soluble compounds may then be converted to insoluble compounds, for example by heating or by treating with a suitable reagent such as an acid.

Brushes embodying this invention wear at only a very slow rate (in a particular typical instance 0.01 inch per hour on a brush containing about 15% rare earth oxides or fluorides) at the low pressures encountered at very high altitudes above 25,000 feet. Moreover, they are characterized by low friction, and low total contact voltage drop, in sliding contact with copper.

I claim:

1. Electrical contact brush comprising a major proportion of a mixture of graphite and copper, and a minor proportion of at least one of the rare earths of the thorium, cerium, and yttrium groups, such rare earth or earths amounting to about 15% by weight of the brush.

2. Electrical contact brush comprising a major proportion of a mixture of graphite and copper, and a minor proportion of at least one fluoride selected from the fluorides of the thorium, cerium, and yttrium groups of rare earth elements, such fluoride or fluorides amounting to about 15% by weight of the brush.

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